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THE WORK OF THE NEWLANDS RECLAMATION PROJECT EXPERIMENT FARM IN 1920 AND 1921.

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AGRICULTURAL CONDITIONS ON THE PROJECT.[1]

ACREAGE, PRODUCTION, AND VALUE OF FARM CROPS.

In the years 1918 and 1919 the high prices paid for farm produce resulted in the reclamation of much new land, the increase during these years being about 5 per cent each year. But in 1920, when prices declined, the increase in irrigated area dropped to 2.9 per cent, and in 1921 to 1.2 per cent. The total area under cultivation in 1919 was 44,324 acres, which was increased to 45,611 acres in 1920 and to 46,143 acres in 1921.

The area devoted to the production of alfalfa was 24,188 acres in 1919 and 26,540 acres in 1920, which is an increase of 9.7 per cent. In 1921 the alfalfa area was 28,287 acres, an increase of 6.6 per cent.

The acreage of barley did not vary greatly from that of previous years, and the wheat area declined from 5,423 acres in 1919 to 3,443 acres in 1920, and to 2,443 acres in 1921. Probably the decline in the market value of wheat accounted in part for the decreased area, but in 1921 some of the land that otherwise would have been used for grain production was planted to sugar beets.

The potato acreage increased from 354 acres in 1920 to 484 acres in 1921. Based on its gross value, the potato crop has risen in importance until it ranks next to alfalfa. About 1,500 acres of sugar beets were planted in 1921, but as the crop was a failure, due to curly-top, this area has been listed in the crop census under the

[1] The Newlands reclamation project is located in western Nevada, surrounding the town of Fallon, on a short branch from the main line of the Southern Pacific Railroad. Its water supply is drawn from the Truckee and Carson Rivers.

heading "Irrigated without crop," or in some cases where there was a partial crop it was included under "Miscellaneous crops."

The average gross income per acre to the farmers was very low just previous to the outbreak of the World War in 1914. From that time it rose steadily until 1919, when the average income was $42.54 per acre, but this period of prosperity was followed in 1920 and 1921 by a rapid decline in the value of farm commodities. The income per acre since 1912 has been as follows:

1912	$12.83	1916	$20.11	1920	$29.80
1913	12.92	1917	35.90	1921	20.70
1914	11.22	1918	38.43		
1915	15.39	1919	42.54		

The lowering of prices during the past two years is resulting in a decided change in the character of the agriculture. The number of dairy cows is being rapidly increased, and more of such crops as muskmelons and potatoes are being produced.

The data given in Table 1 have been compiled from the crop census taken by the United States Reclamation Service in November of each year. In this table the acreage, production, and market values of the leading crops of the project are summarized for the years 1920 and 1921.

TABLE 1.—*Acreage, yields, and farm values of crops produced on the Newlands reclamation project in 1920 and 1921.*

Crop.	Area (acres).	Yield.			Farm values		
		Unit.	Total.	Average per acre.	Per unit of yield.	Total.	
1920.							
Alfalfa hay	26,540	Ton	92,819	3.50	$10.00	$928,190	
Alfalfa planted in 1920	4,254	do	581	.14	10.00	5,810	
Hay (other than alfalfa)	505	do	751	1.49	10.00	7,510	
Pasture, alfalfa						48,317	
Pasture, grass	9,720					28,340	
Barley	769	Cwt	10,800	14.04	3.25	35,100	
Oats	68	do	1,080	15.88	2.50	2,700	
Wheat	3,586	do	54,920	15.32	3.75	205,950	
Potatoes	354	do	22,080	62.37	2.00	44,160	
Garden	277					25,733	
Miscellaneous crops	376					27,506	
Irrigated without crops	1,038						
Duplications	1,876						
Net acreage irrigated	45,611						
Total value of crops						1,359,316	
Average income per acre							
1921.							
Alfalfa hay	28,287	Ton	95,561	3.38	7.00	668,927	
Alfalfa planted in 1921	2,923	do	268	.09	7.00	1,876	
Hay (other than alfalfa)	247	do	289	1.17	7.00	2,023	
Pasture, alfalfa						33,499	
Pasture, grass	7,874					16,925	
Barley	732	Cwt	9,380	12.81	1.25	11,725	
Oats	60	do	960	16.00	1.50	1,440	
Wheat	2,443	do	40,120	16.42	1.50	60,180	
Muskmelons	129					14,692	113.90
Potatoes	484	Cwt	55,840	115.37	1.85	103,304	213.43
Garden	276					27,580	99.93
Miscellaneous crops	1,172					12,970	11.07
Irrigated without crop	2,710						
Duplications	1,194						
Net acreage irrigated	46,143						
Total value of crops						955,140	
Average income per acre							20.70

In order to indicate the progress or decline that has occurred in the production of the leading crops, Table 2 has been prepared, showing the acreage and production of alfalfa, barley, wheat, oats, and potatoes from 1912 to 1921, inclusive. Alfalfa is the only crop that has shown a steady and consistent increase in acreage. The areas devoted to all crops other than alfalfa show decided fluctuation from year to year.

TABLE 2.—*Acreage and production of leading crops on the Newlands reclamation project, during the 10-year period from 1912 to 1921, inclusive.*

Year.	Alfalfa.		Barley.		Oats.		Wheat.		Potatoes.	
	Acres.	Tons.	Acres.	Bushels.	Acres.	Bushels.	Acres.	Bushels.	Acres.	Bushels.
1912	12,912	33,595	2,259	74,792	399	16,875	2,484	40,600	483	65,633
1913	13,960	45,132	1,880	43,238	283	19,274	1,590	30,271	416	29,789
1914	18,212	59,873	1,329	31,084	417	18,000	1,446	29,164	283	23,800
1915	18,273	53,496	1,733	49,585	428	14,375	2,582	34,065	196	25,133
1916	19,541	61,756	1,658	52,000	107	4,566	2,861	57,733	177	29,400
1917	20,360	72,769	1,116	26,833	27	938	2,532	43,233	322	56,433
1918	21,542	77,442	1,374	35,333	44	1,856	5,024	98,800	334	50,833
1919	24,188	92,850	519	10,875	31	937	5,423	83,266	152	24,366
1920	26,540	92,819	769	22,500	68	3,375	3,586	91,533	354	36,800
1921	28,287	95,567	732	19,541	60	3,000	2,443	66,866	484	93,067

LIVE-STOCK PRODUCTION.

From the annual live-stock census of the United States Reclamation Service, the statistics shown in Table 3 have been summarized. This table indicates the number of dairy cattle, hogs, and fowls on farms on the project in November of each year since 1914.

TABLE 3.—*Number of dairy cows, hogs, and fowls on hand on the Newlands reclamation project during the 8-year period from 1914 to 1921, inclusive.*

Year.	Dairy cattle.	Hogs.	Fowls.		Year.	Dairy cattle.	Hogs.	Fowls.	
			Turkeys.	All others.				Turkeys.	All others.
1914	1,503	3,815	6,972	27,399	1918	1,895	3,343	4,746	20,220
1915	2,433	4,836	12,000	22,912	1919	1,850	3,048	3,442	25,932
1916	2,537	6,092	15,239	29,270	1920	2,072	2,211	3,624	28,780
1917	2,044	3,170	9,042	24,056	1921	3,597	1,793	4,834	28,582

It is shown that while the dairy industry suffered a material decline during the war, it is again coming back so rapidly that the number of cows on the project practically doubled during the two years ending in November, 1921. When the price of alfalfa hay was high during and immediately following the war period, dairying became relatively unpopular, and from 1916 to the first months of 1920 the number of dairy cows steadily decreased. When, in 1920, the market prices of alfalfa and the grain crops suddenly dropped, the dairy-cow situation changed immediately and a sudden demand for cows occurred. Since that time dairy cows have been in great demand and importations from other States have been constant.

Hogs have decreased in numbers until there are now fewer than at any time during the period under consideration. The reason for this reduction in the number of hogs is not clear, for all experiments so far conducted have shown that the growing of them has been

profitable, even under conditions less favorable than those of the past few years. The census of 1921 showed that there were only about half as many hogs on hand as dairy cows.

Table 4 summarizes from the annual census of the United States Reclamation Service the numbers and values of the various kinds of live stock on the Newlands project in 1919, 1920, and 1921.

TABLE 4.—*Number and estimated value of live stock on the Newlands reclamation project in 1919, 1920, and 1921.*

COMPARISON OF 1919 AND 1920.

Item.	Inventory, Dec. 31 (number).				Values in 1919.		Values in 1920.			
	1919	1920	1920		Unit.	Total.	Unit.	Total.	In-crease.	De-crease.
			In-crease.	De-crease.						
Horses	3,256	3,641	385	.....	$80.40	$261,785	$89.68	$326,540	$64,755	.....
Mules	276	234	.....	42	74.05	20,440	105.22	24,621	4,181	.....
Cattle:										
Dairy	1,850	2,072	222	.....	99.61	184,285	98.91	204,940	20,655	.....
All other	6,778	7,428	650	.....	48.92	331,620	37.88	281,390	.....	$50,230
Sheep	3,347	4,611	1,264	.....	10.34	34,612	10.20	47,067	12,455	.....
Hogs	3,048	2,211	.....	837	14.48	44,137	14.22	31,443	.....	12,694
Fowls:										
Turkeys	3,442	3,624	182	.....	3.94	13,563	3.67	13,310	.....	253
All other	29,932	28,780	.....	1,152	.85	25,232	1.03	29,438	4,206	.....
Bees, hives	2,821	2,683	.....	138	16.73	47,254	14.43	38,721	.....	8,533
Total	.....	.....	.....	.....	.....	962,928	.....	997,470	106,252	71,710
Net increase in value	.....	.....	.....	.....	.....	.....	.....	.....	34,542	.....

COMPARISON OF 1920 AND 1921.

Item.	Inventory, Dec. 31 (number).				Values in 1920.		Values in 1921.			
	1920	1921	1921		Unit.	Total.	Unit.	Total.	In-crease.	De-crease.
			In-crease.	De-crease.						
Horses	3,641	3,697	56	.....	$89.68	$326,540	$81.75	$302,244	.....	$24,296
Mules	234	341	7	.....	105.22	24,621	69.32	23,640	.....	981
Cattle:										
Dairy	2,072	3,597	1,525	.....	98.91	204,940	96.96	348,780	$143,840	.....
All other	7,428	6,732	.....	696	37.88	281,390	47.39	318,083	36,693	.....
Sheep	4,611	7,707	3,096	.....	10.20	47,067	5.53	42,647	.....	4,420
Hogs	2,211	1,793	.....	418	14.22	31,443	10.88	19,509	.....	11,934
Fowls:										
Turkeys	3,624	4,834	1,210	.....	3.67	13,310	3.68	17,758	4,448	.....
All other	28,780	28,582	.....	198	1.03	29,438	1.03	29,499	61	.....
Bees, hives	2,683	2,983	300	.....	14.43	38,721	10.58	31,551	.....	7,170
Total	.....	.....	.....	.....	.....	997,470	.....	1,133,711	185,042	48,801
Net increase in value	.....	.....	.....	.....	.....	.....	.....	.....	136,241	.....

CHARACTER OF THE WORK IN PROGRESS.

In 1920 the work of the Newlands Experiment Farm [2] was interrupted on July 1 because of the lack of appropriations. Most of the experiments started in the spring were discontinued and little or no

[2] The Newlands Experiment Farm is located on the Newlands reclamation project, about 1 mile south of the town of Fallon. The tract consists of 160 acres withheld from entry by the Department of the Interior and set aside for use as an experiment farm.

data obtained. One man was left in charge as caretaker between July 1, 1920, and March 5, 1921, when regular work was resumed.

The main lines of work conducted at the experiment farm are (1) recording weather conditions, (2) tests of general farm crops, (3) tests of horticultural crops, (4) field experiments in the reclamation of alkali soil, and (5) laboratory research relating to local problems in crop production.

WEATHER CONDITIONS.

Weather records are kept in cooperation with the United States Weather Bureau and the Biophysical Laboratory of the Bureau of Plant Industry.

TABLE 5.—*Summary of climatological observations at the Newlands Experiment Farm for the 16-year period from 1906 to 1921, inclusive.*

Year, etc.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
PRECIPITATION (INCHES).												
Average for 16 years[1]	0.70	0.44	0.42	0.50	0.51	0.35	0.17	0.27	0.37	0.33	0.25	0.53
For 1921	.06	.03	.07	0	1.64	.66	.01	.10	.28	0	.18	1.40
EVAPORATION (INCHES).												
Average for 14 years[2]	1.16	1.80	4.14	6.27	8.30	9.96	10.90	9.74	6.61	3.92	2.05	.94
For 1921	.74	1.83	4.05	6.96	8.60	9.49	11.42	9.57	.....	.....	.....	.....
DAILY WIND VELOCITY (MILES PER HOUR).												
Average for 13 years[3]	3.1	3.7	4.7	5.4	4.8	4.0	3.1	2.8	2.9	2.6	2.7	2.7
For 1921	.....	.....	.....	5.5	4.5	2.5	1.7	1.7	2.1	1.3	1.3	2.1
ASPECT OF THE SKY (DAYS).												
Average for 16 years:[4]												
Clear	13.9	14.1	17.8	17.4	17.6	22.3	23.6	25.1	22.1	22.7	18.0	14.6
Partly cloudy	9.3	7.3	7.9	7.0	8.8	4.4	4.9	3.7	4.3	3.5	6.1	6.8
Cloudy	7.9	6.9	5.3	5.6	4.6	3.3	2.5	2.2	3.6	4.8	5.9	9.5
For 1921:												
Clear	19	24	24	12	14	22	28	30	26	23	18	15
Partly cloudy	9	2	7	1	5	1	1	0	2	2	4	2
Cloudy	3	2	0	17	12	7	2	1	2	6	8	14
TEMPERATURE (°F.).												
Average for 16 years:[5]												
Absolute maximum	58.9	64.4	74.1	81.1	87.9	95.6	100.1	99.1	91.6	82.8	72.4	61.6
Daily maximum	43.7	50.0	59.0	66.4	72.6	83.4	93.0	91.5	80.3	67.9	55.9	44.6
Absolute minimum	0.2	7.6	16.1	20.4	28.1	36.0	43.8	41.2	30.1	19.8	9.5	3.7
Daily minimum	17.7	23.0	27.9	34.5	40.5	47.3	54.1	51.7	42.6	32.8	24.1	18.9
Monthly mean	30.6	36.5	43.4	50.5	56.6	65.3	73.5	71.5	61.3	50.4	40.0	31.7
16-year record:[5]												
Highest recorded	70.0	78.0	79.0	89.0	102.0	101.0	105.0	103.0	95.0	89.0	81.0	72.0
Lowest recorded	−25.0	−12.0	9.0	13.0	21.0	31.0	38.0	36.0	26.0	13.0	−1.0	−4.0
For the year 1921:												
Absolute maximum	66.0	78.0	78.0	80.0	89.0	97.0	101.0	99.0	90.0	86.0	74.0	67.0
Mean maximum	50.3	56.4	65.7	65.8	72.9	85.1	95.0	92.7	81.3	74.9	62.4	47.9
Absolute minimum	8.0	6.0	15.0	16.0	27.0	36.0	38.0	44.0	30.0	20.0	10.0	3.0
Mean minimum	23.5	21.6	28.7	32.1	41.2	49.3	53.5	51.3	39.3	32.9	24.7	19.9
Mean	36.9	39.0	47.2	48.9	57.0	67.2	74.3	72.0	60.3	53.9	43.6	33.9

[1] The records for January, February, and March cover only 15 years.
[2] The January and February records are for 10 years; records for April, May, June, July, and August are for 13 years.
[3] The records for January, February, March, and November cover only 11 years; those for May, June, July, August, and September are for 13 years.
[4] The records for January, February, March, and October cover only 15 years.
[5] The records for March and October cover only 15 years.

TABLE 5.—*Summary of climatological observations at the Newlands Experiment Farm for the 16-year period from 1906 to 1921, inclusive*—Continued.

KILLING FROSTS.

Year.	Last in spring.	First in autumn.	Frost-free period (days).	Year.	Last in spring.	First in autumn.	Frost-free period (days).
1906	May 31	Oct. 4	125	1915	May 20	Sept. 14	116
1907	May 14	Sept. 19	127	1916	June 1	Sept. 10	100
1908	May 30	Sept. 25	117	1317	May 21	Sept. 25	126
1909	May 24	Sept. 22	120	1918	May 29	Oct. 7	130
1910	May 16	Sept. 23	129	1919	May 6	Sept. 22	138
1911	May 27	Sept. 18	113	1920	May 3	Sept. 25	144
1912	May 22	Sept. 25	125	1921	May 29	Sept. 13	106
1913	May 13	Sept. 23	132				
1914	Apr. 24	Sept. 9	137	Average	May 20	Sept. 22	124

The length of the frost-free period in 1920 was 144 days, extending from May 3 to September 25. This is 20 days longer than normal and was favorable to the maturing of corn and such vegetable crops as tomatoes, muskmelons, and watermelons, which frequently have their yields greatly reduced by early autumn frosts.

In 1921 the season was cut short at both ends, the last killing frost in spring having occurred May 29 and the first in autumn on September 13. The length of the frost-free period was 106 days, which is 18 days shorter than normal.

The precipitation in both 1920 and 1921 was about normal. The total rainfall in 1920 was 5.01 inches. The heaviest rain of the year occurred August 25 and 26, when much of the second-crop alfalfa was still in shock, resulting in great damage to the crop.

In 1921 unusually heavy rains occurred in May and December, but at these seasons of the year there was little or no damage to crops, the only ill effects being to put roads in bad condition so as to interfere somewhat with the marketing of hay.

In January, February, and March, 1921, the mean temperature was several degrees higher than normal, followed by weather in April which was colder than usual. The warm winter months brought an unusually early appearance of the fruit blossoms, which were frozen during the cold weather of April, so that practically no fruit was produced within the project in 1921.

In Table 5 the weather conditions are given for the year 1921 and are compared with the averages obtained during the past 15 years.

VARIETAL AND CULTURAL TESTS OF FIELD CROPS.

COMPARATIVE TESTS OF SORGHUM VARIETIES.

Five varieties of sorghum were planted on May 24, 1921, with a garden drill, in plat A3, in rows 3½ feet apart. Early Amber was the only variety to mature seeds. This is in accord with the results obtained in some previous tests, especially in unfavorable years, when the season was too short or too cold for feterita, milo, and Egyptian corn to mature. It will be noted that the frost-free period in 1921 was 18 days shorter than the normal. When the frost-free period is normal feterita is able to mature. Because of the variable results obtained and the uncertainty of obtaining a seed crop these varieties can not be recommended for grain production. Early

Amber sorghum may be grown as a forage crop or for the production of sorghum molasses. When planted on good soil it produces from 3 to 5 tons of air-dried fodder per acre. If grown for sirup it is estimated from the fodder yields that from 75 to 100 gallons of sirup per acre would be secured. It is recommended that the manufacture of sorghum sirup be encouraged as a minor industry of this project. Broom corn produces a good quality of brush, and the growing of broom corn and the making of brooms might well be adopted by the Indians as a source of profitable employment.

The yields of the sorghum varieties obtained in 1921 are given in Table 6.

TABLE 6.—*Yields of sorghum varieties on the Newlands Experiment Farm in 1921.*

Name of crop.	Row-length (feet).	Yield (pounds).		
		Total.	Per 100-foot row.	Per acre.
Egyptian corn	560	435	77.68	9,668
Dwarf milo	560	370	66.07	8,223
Feterita	560	420	75.00	9,335
Dwarf broom corn	544	305	56.06	6,977
Early Amber	544	415	76.29	9,495

MILLET.

Both hog millet and Japanese millet were planted in some newly leveled plats in field C in 1921. The soil proved to be somewhat spotted, but where the soil was good both crops made a rank growth, the Japanese variety in some cases reaching a height of 6 feet. The Japanese millet produced 2,696 pounds of hay per acre. The hay production of this variety on uniformly good soil would greatly exceed this amount. It has been found that the Japanese millet is a little more tolerant of alkali soil than any of the other varieties. Hog millet is useful and may be grown where a short-season crop is desired. A characteristic of this variety that gives it some advantage over others is that the seeds ripen while the stalks are still green, thus making it possible to get some value from the straw in addition to the seed crop.

POTATO EXPERIMENTS IN 1920.

The potato experiments in 1920 included the following:

(1) Comparison of whole and cut seed.
(2) Comparison of small, medium, and large seed pieces.
(3) Effect on yield of distance of planting.
(4) Test of varieties.

Plantings were made on May 4, 1920, in plats 8, 9, and 10, field H. The rows were 3½ feet apart and the seed pieces were spaced 18 inches apart in the row, except in the distance-of-planting test. The crop was harvested on October 18, 19, and 20. The soil in the field was very spotted, and, as this crop is exceedingly sensitive to soil variations, large differences in yields of rows of the same kind were obtained. The experimental error was large and the results often of doubtful value, even in the duplicated or multiplicated experiments.

WHOLE POTATOES COMPARED WITH CUT SEED.

For comparison with cut seed fairly uniform, medium-sized potatoes were selected from the bin, and those intended for use in the cut-seed rows were cut lengthwise in halves. It will be noted by reference to Table 7, in which the results of this experiment are summarized, that the net yield of marketable tubers was 76 pounds from the whole seed and 65 pounds from the cut seed. The difference, while favoring the planting of whole seed, is not large enough to be highly significant.

TABLE 7.—*Whole potatoes compared with cut tubers for seed on the Newlands Experiment Farm in 1920.*

Series.	Yield (pounds).								
	Whole seed.				Cut seed.				Net increase in marketable potatoes from whole seed.
	Marketable.	Total.	Seed used.	Net yield marketable.	Marketable.	Total.	Seed used.	Net yield marketable.	
No. 1	140	163	12	128	134	159	7	127	1
No. 2	106	126	13	93	62	89	7	55	38
No. 3	77	110	12	65	64	85	7	57	8
No. 4	80	109	16	64	49	66	9	40	24
No. 5	41	68	14	27	53	79	8	45	−18
Total	444	576	67	377	362	478	38	324	53
Average	89	115	13	76	72	96	7	65	11

COMPARISON OF SMALL, MEDIUM, AND LARGE SEED POTATOES.

For comparison as to size potato tubers of three grades were selected from the bin. Those weighing under 4 ounces were classed as small, 4 to 8 ounces as medium, and those over 8 ounces as large. To plant a row 6 pounds of small seed was required, 11½ pounds of medium, and 23½ pounds of large. The experiment was performed in duplicate, and the average yield of marketable potatoes per 150-foot row was found to be 150 pounds from the small seed, 166 pounds from the medium, and 185 pounds from the large. The increased yield resulting from the use of the large tubers for seed is in accord with the results of experiments of previous years.

TABLE 8.—*Yields of potatoes in the distance-of-planting tests on the Newlands Experiment Farm in 1920.*

Distance of planting.	Yield per 150-foot row (pounds).				Culls (per cent).
	Series.			Average.	
	1	2	3		
12 inches	140	131	122	131±2.9	13.6
18 inches	88	135	109	111±7.5	13.5
24 inches	154	118	106	126±7.9	9.4

EFFECT ON YIELD OF DISTANCE OF PLANTING.

For comparison of the distance of planting, medium-sized potato tubers were selected from the bin and cut as nearly as practicable into pieces of uniform size. This seed was then dropped in rows with the pieces at intervals of 12, 18, and 24 inches. The experiment was performed in triplicate. The results (Table 8) do not indicate any consistent differences in yield.

TEST OF POTATO VARIETIES.

Ten varieties of potatoes were included in the variety test. Because of the spottedness of the soil, the Burbank was planted in alternate rows as a check, and in Table 9, in which the results of this test are summarized, the yield of each variety is compared with the yield of the adjoining rows of Burbank. It was noted at harvest time that most other varieties were smoother and had a smaller percentage of culls than the Burbank, which is in accord with the observations of all previous years. In this test the Producer, Netted Burbank, and Early Freeman were the three varieties ranking best in production.

TABLE 9.—*Yields of potatoes in the varietal tests on the Newlands Experiment Farm in 1920.*

Variety.	Yield per 150-foot row.			Marketable crop.			Total crop.	
	Culls.	Marketable.	Total.	Ratio to total.	Comparison of variety with nearest check plats.		Comparison of variety with nearest check plats.	
					Average of adjoining check plats.	Ratio of variety yield to check-plat yield.	Average of adjoining check plats.	Ratio of variety yield to check-plat yield.
	Pounds.	*Pounds.*	*Pounds.*	*Per cent.*	*Pounds.*	*Per cent.*	*Pounds.*	*Per cent.*
Burbank check	13	15	28	54	.....	.....	.....	.....
Irish Cobbler	9	26	35	74	24.5	106	38.5	91
Burbank check	15	34	49	69	.....	.....	.....	.....
Earliest of All	4	34	38	89	35.0	97	55.0	69
Burbank check	25	36	61	59	.....	.....	.....	.....
Netted Burbank	5	44	49	90	29.5	149	47.0	104
Burbank check	10	23	33	70	.....	.....	.....	.....
Producer	9	57	66	86	31.5	181	44.0	150
Burbank check	15	40	55	73	.....	.....	.....	.....
Early Freeman	7	48	55	87	41.0	117	63.0	87
Burbank check	29	42	71	59	.....	.....	.....	.....
American Wonder	13	42	55	76	52.0	81	80.0	69
Burbank check	27	62	89	70	.....	.....	.....	.....
Colorado Pearl	3	48	51	94	48.5	99	72.0	71
Burbank check	20	35	55	64	.....	.....	.....	.....
Blue Victor	3	37	40	92	33.5	110	55.5	72
Burbank check	24	32	56	57	.....	.....	.....	.....
Scotch Rose	15	18	33	55	37.5	48	64.0	52
Burbank check	29	43	72	60	.....	.....	.....	.....

The varieties that were tested as shown in Table 9 are rearranged in Table 10 to show the order of the ratio of yield of the marketable crop when compared with the adjoining check rows, this being taken as indicative of the relative value of the variety. The rank according to the actual yield of marketable tubers is also given.

TABLE 10.—*Potato varieties arranged in the order of the yield of marketable tubers in relation to check rows in 1920.*

Variety.	Ratio.	Rank according to yield.		Variety.	Ratio.	Rank according to yield.	
		Relative.	Actual.			Relative.	Actual.
Producer	181	1	1	Burbank (used as check)	100	6	7
Netted Burbank	149	2	4	Colorado Pearl	99	7	3
Early Freeman	117	3	2	Earliest of All	97	8	8
Blue Victor	111	4	6	American Wonder	81	9	9
Irish Cobbler	106	5	9	Scotch Rose	47	10	10

TABLE 11.—*Summarized results of the corn-variety test on the Newlands Experiment Farm in 1921.*

Rank.	Variety.	Source.	Ear corn.	Dry corn.	Dried ear corn.	Shelling ratio.	Shelled corn.	Average yield of nearest checks.	Ratio to checks.
			Pounds	*Per cent.*	*Pounds*	*Per cent.*	*Pounds*	*Pounds*	*Per cent.*
1	Medium Fodder	Disco	29.0	59	17.1	81	13.8	10.9	127
			47.0	63	29.6	83	24.5	13.4	183
2	Wimples Yellow Dent	do	45.2	66	29.8	82	24.0	18.6	129
			27.5	68	18.4	83	15.3	9.5	161
3	Oregon White Dent	Port	33.3	76	25.4	84	21.3	11.6	184
			35.8	63	22.5	75	16.9	17.5	96
4	Riverview Special	Disco	28.2	73	20.7	81	16.8	11.3	149
			40.8	62	25.3	82	20.8	16.5	126
5	Early Fodder	do	21.0	75	15.8	85	13.4	9.4	144
			42.8	62	26.5	80	21.2	17.5	121
6	Minnesota No. 13	do	31.2	68	21.2	81	17.1	13.6	126
			38.2	59	22.5	81	18.1	13.3	136
7	King Philip	do	46.7	71	33.2	80	26.6	17.4	153
			13.0	64	8.3	76	6.3	8.5	74
8	Early Murdock	do	42.5	61	26.0	80	20.8	18.8	111
			39.8	63	25.1	81	20.4	18.4	111
9	Pride of the North	do	36.6	66	24.2	84	20.3	18.4	111
			26.0	71	18.5	83	15.4	14.6	106
10	White Flint	Port	23.3	62	14.5	74	10.7	11.8	91
			57.0	53	30.3	72	21.8	18.3	119
11	90-Day White	Disco	35.3	63	22.3	83	18.5	19.2	96
			21.5	66	14.2	82	11.6	10.5	110
12	White Flint	do	43.8	63	27.7	81	22.4	19.1	117
			16.9	61	10.3	82	8.5	9.7	88
13	Pride of the North (check)	Port	35.3	51	17.9	79	14.2	14.2	100
14	Disco Pride	Disco	21.6	73	15.8	82	13.0	16.4	79
			16.8	72	12.1	84	10.2	14.2	72
15	Northwestern Dent	do	28.7	72	20.7	73	15.1	19.4	78
			9.6	76	7.3	78	5.7	10.2	56
16	Squaw	do	29.5	71	21.0	84	17.7	18.1	98
			5.0	78	3.9	81	3.2	9.0	36

CORN VARIETY TESTS.

In 1921, 16 varieties or strains of field corn were planted in duplicate in plats 8, 9, and 10 of field H. Pride of the North was planted in every third row as a check variety. In calculating relative yields each variety is compared with the two nearest check rows. This seems to be the only practical way of meeting the problem of soil variation. The results are summarized in Table 11, where the varieties are arranged as nearly as possible in the order of yield. It appears that the five varieties producing the greatest yields of mature corn were (1) Wimples Yellow Dent, (2) Oregon White Dent, (3) Riverview Special, (4) Early Fodder, and (5) Minnesota No. 13 (not well matured). Medium Fodder produced the most grain, but this variety did not mature. In a season when the frost-free period is of normal length this variety probably would be very productive.

In Table 11 the abbreviation "Port" indicates that the seed was purchased from the Portland Seed Co., and the abbreviation "Disco" indicates that the source was the Dakota Improved Seed Co. The yields given indicate the corn obtained per 100-foot row.

EFFECT OF MANURE ON CROP YIELDS.

The results of experiments for four years are now available in which the effect of manure on yields of wheat and corn has been determined. In these experiments the wheat and corn alternate, and the corn is manured previous to planting. The increased yield of the wheat results from a hold-over effect from manuring the land for the previous corn crop. It is noticeable that both the wheat and corn on the manured plats are darker green in color and make a more rank growth than on the unmanured plats. As shown in Table 12, the average wheat yield for four years on the manured rotation was 21.3 bushels and on the unmanured 17 bushels per acre, an increase of 25 per cent.

The yields given in Table 12 for the corn represent tons per acre of green fodder, except in 1917 when the fodder was air dried. The averages show a yield of 4½ tons on the manured and 3⅘ tons per acre on the unmanured, an increase of 18½ per cent as a result of the application of manure. The gradual decline in yield of the wheat crop is not understood.

TABLE 12.— *Yields of wheat and fodder corn showing the effect of manure on the Newlands Experiment Farm during the four years indicated.*

Year.	Wheat (bushels).		Corn (tons).	
	Manured.	Unmanured.	Manured.	Unmanured.
1917	30.0	23.4	1.8	1.9
1918	22.8	16.4	5.2	3.2
1919	19.3	18.2	4.0	3.9
1921	12.9	10.0	7.0	6.3
Average	21.3	17.0	4.5	3.8

PASTURE GRASSES.

Pasture grasses have been grown on the Newlands Experiment Farm for several years, and trials have been made on a few private farms in various parts of the project. It has not been possible to obtain accurate yields, but it is estimated that a pasture of mixed grasses on fairly productive soil will support from 1½ to 2 cows per acre during the growing season. An experiment conducted in the Fernley district a few years ago indicated that the soil of that district is particularly well adapted to grass production. Grasses do not grow well either in alkaline soils or in light sand. If a field is to be seeded to permanent pasture, good land should be selected or the results will be unsatisfactory. The mixture used by the experiment farm is as follows:

White Dutch clover	pound	1	Kentucky bluegrass	pound	2
Alsike clover	do	1	Redtop	do	2
Brome-grass (*Bromus inermis*)	do	5	Meadow fescue	do	2
Tall oat-grass	do	5			
Orchard grass	do	4	Total	do	25
English or perennial rye-grass	do	3			

Since most of the grass seeds are very small it is important to prepare the seed bed with unusual care. The seed may be broadcasted by hand or with a grass seeder. If seeded by machine it is not advisable to mix the coarse and fine seeds, as the latter tend to work to the bottom of the box. Cover the seeds lightly with a harrow or preferably with a brush drag. Since they are planted so near the surface, it is necessary to keep the ground moist by frequent irrigation until the seeds have sent their roots down into more uniformly moist soil than is found at the surface.

On the poorer soils sweet clover may often be profitably used as a pasture crop. The dairy cows on the experiment farm have been pastured for several years on sweet clover with excellent results. This crop is more productive than pasture grasses, is much less expensive to seed, the risk of failure in getting a stand is less, and it will produce a crop on poorer soils than the grasses. Tests made by shifting the cows alternately every two weeks between the grass and sweet-clover pastures showed that the milk production was as great from the sweet clover as from the grasses.

In addition to the experiments with pasture mixtures, as noted above, a series of small plats has been devoted to experiments with the individual varieties of grasses and clovers. These experiments, to be described in detail later, are proving useful in the selection of mixtures for establishing pastures. A view of these small experimental plats is shown in Figure 1.

TESTS OF HORTICULTURAL CROPS.

TOMATO VARIETIES.

In 1921 tests were conducted with six varieties of tomatoes, two of which had not been previously tried. Earliana was the first variety to produce fruit and was also the heaviest yielding variety. Burbank, one of the new varieties, was the second earliest and practically equaled the Earliana in production. The yield of the other varieties fell far below these two. The character of the season was such that earliness was the most important factor in obtaining

good yields. This year the Fusarium blight was very pronounced, the average loss among the varieties being 15½ per cent of those planted. The yields of all varieties were materially decreased by the killing frosts in September, at which time the Earliana and

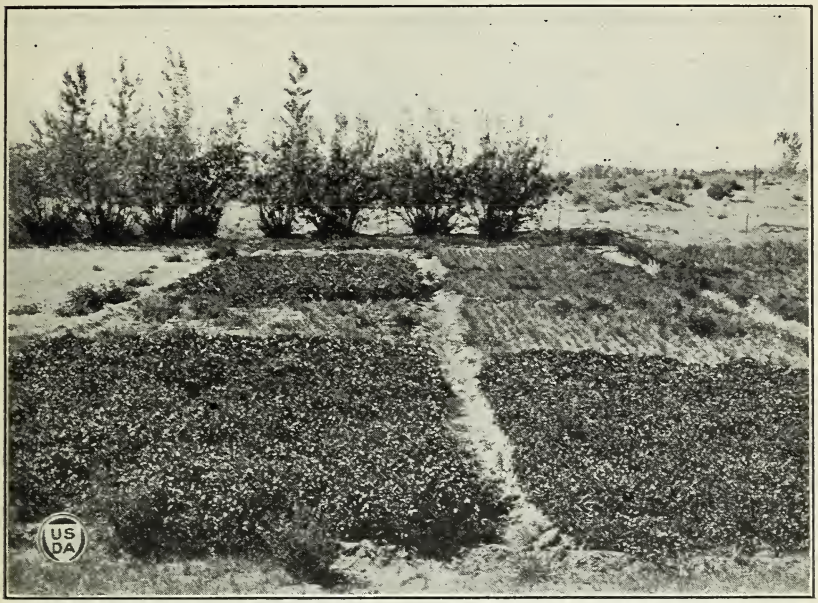

FIG. 1.—Experimental plats of varieties of clover and grass on the Newlands Experiment Farm.

Burbank were at the maximum production, while the four other varieties were just beginning to bear. The yields are given in Table 13.

TABLE 13.—*Tomato variety test on the Newlands Experiment Farm in 1921.*

Variety.	Date of first picking.	Number of plants.			Yield (pounds).	
		Original.	Removed by blight.	Remaining.	Total.	Average per plant.
Earliana	July 23	63	11	52	292.5	5.6
Burbank	Aug. 10	32	10	22	120.5	5.5
Stone	Sept. 5	27	3	24	54.0	2.3
Dwarf Champion	Aug. 22	24	1	23	36.0	1.6
Santa Rosa	Sept. 5	28	4	24	30.5	1.3
Coreless	do	26	2	24	18.0	.8

CABBAGE VARIETIES.

The data obtained in 1921 on eight varieties of cabbage lead to the conclusion that this crop can be grown profitably in this locality. Of the varieties tried the Ideal Winter, Copenhagen Market, and Danish Ballhead produced the heaviest heads. The soil was relatively uniform, and the results indicate fairly well the productiveness of the varieties. The results of the experiment are summarized in Table 14.

TABLE 14.—*Test of cabbage varieties on the Newlands Experiment Farm in 1921.*

Variety.	Number of heads harvested.	Weight of heads (pounds).		Variety.	Number of heads harvested.	Weight of heads (pounds).	
		Total.	Average.			Total.	Average.
Ideal Winter	130	1,011.0	7.8	Surehead	20	94.5	4.7
Copenhagen Market	27	183.5	6.8	New Volga	25	97.0	3.9
Danish Ballhead	127	661.0	5.2	Winningstadt	13	45.0	3.5
Eureka First Early	29	130.5	4.5	Jersey Wakefield	28	96.5	3.4

BLOSSOMING DATES OF FRUIT TREES.

Blossoming records have been kept of all fruit trees in the orchards since 1916. There is a pronounced variation from year to year in the dates of the first opening of buds. The date of the first opening of apple blossoms during a period of six years has been as follows:

1916, 17 trees on April 17.
1917, 21 trees on May 7.
1918, 21 trees on April 29.
1919, 35 trees on April 24.
1920, 36 trees on May 2.
1921, 30 trees on April 11.

Average date April 25.

In this period of six years there were two years of early blooming viz, 1916 and 1921, and it is to be noted that these are the only years when the fruit crop was a failure and that in the other four years either fair or full fruit crops were obtained. It is apparent that early blossoming of the trees is here associated with low fruit production.

TROUBLESOME INSECT PESTS IN ORCHARDS.

In the early spring, while the trees are still dormant, it is the practice at the Newlands Experiment Farm to spray all fruit trees with lime-sulphur solution in order to keep the red spider, or spider mite, under control. In some orchards where control measures are not used this pest becomes so numerous as to check the growth and in some cases to cause the death of fruit trees. Immediately after spraying for red spider the trunks of all fruit trees are sprayed with whitewash as a protection against sun scald.

For the small orchards, common on the Newlands project, the apparatus required for spraying is not expensive and should be more generally used. The equipment and method of spraying are shown in Figure 2.

The codling moth is so serious a pest that practically all apples are wormy unless the trees are sprayed at the proper time in spring. Two sprayings with arsenate of lead are given to apples and pears. The first spray is applied just after the blossoms have fallen, followed by a second spraying in about two weeks. A few farmers in the project have practiced spraying while the trees are in full bloom, which has resulted in a few cases in the poisoning of honeybees, and the bee growers have made complaint against the practice. Bees and fruit trees are mutually beneficial, for the former obtain honey from the blossoms and the latter depend upon the bees for the pollination which is so necessary for the production of fruit. Farmers should take care, in using arsenicals, that they be applied at a time when the honeybees are not active in the trees

ORNAMENTAL TREES.

The farmers of the Newlands project have been very progressive in the matter of planting trees, and sections which were practically destitute of trees 12 years ago now have groves around nearly every farm home. Newcomers frequently comment upon this and express surprise that so many trees should have been grown on so new a project.

In order to attain quick results nearly everyone has planted the rapid-growing poplars and cottonwoods. This was undoubtedly the best thing to do under the circumstances, for young trees were to be had for the asking; and these grew into large ones in a remarkably short period of time.

Now that there is such an abundance of cottonwoods and Carolina poplars, the addition of more of the same varieties does not add

FIG. 2.—Spraying fruit trees with lime-sulphur on the Newlands Experiment Farm, showing a desirable type of spray pump for use in small orchards.

greatly to the beauty of the landscape. More pleasing results can now be obtained by planting a number of varieties of trees and shrubs. Rapid growth is no longer so desirable as diversity of form and color.

The Chinese poplar is one of the most attractive of the poplar family. (Fig. 3.) It makes rapid growth, has finer and more graceful branches than the Carolina poplars, and has the added advantage of putting out its leaves in the spring from two to three weeks earlier than most other varieties. It is easily propagated from cuttings, which may be obtained at the experiment farm.

The black locust is a hardy tree, well adapted to the soil and climatic conditions of the Newlands project. It is attractive as an

ornamental tree and is valuable as a source of supply of hardwood timber suitable for fence posts, doubletrees, and other purposes. It may be propagated from seeds, or small seedlings may be purchased from nurserymen at a very low cost.

The Karagatch elm and the Chinese elm (*Ulmus pumila*) have proved to be the most satisfactory of any of the hardwoods tried up to this time. They make more rapid growth than the American elm and are more resistant to alkali in the soil.

Box elders and soft maples make fairly good growth and when planted among other varieties add a diversity of form and color. The Russian olive may be used as a hedge or individual trees may

FIG. 3.—Chinese balsam poplar on the Newlands Experiment Farm. This tree has several characteristics which make it particularly desirable for the Newlands project. Like other poplars, it makes rapid growth, but is more attractive in form and comes into full leaf about three weeks ahead of the Carolina and Norway poplars, as shown here.

be dispersed among the usual shade trees, where, because of their light-gray foliage, they will stand out in marked contrast to the darker green of the others. (Fig. 4.)

EXPERIMENTS IN THE RECLAMATION OF ALKALI SOILS.

The experiment in the reclamation of alkali soils is located on plats 9 and 10 of field B where the soil is of such nature that a hard, cement-like crust forms after each irrigation or rain. Many of the seeds which germinate are unable to break their way through the crust, and the plants which do emerge on the untreated plats grow to a height of only a few inches during the season. The treatments given consisted of the application of manure, gypsum, sulphur, and

acid phosphate. The applications were made singly and in combination.

The experiment has now been conducted for three seasons, using wheat in 1919 and corn in 1920 and 1921 as the indicator crop. The conditions of growth of corn on the various plats of these two series are shown in Figures 5 to 9. In the spring of 1919 two large plats, B9 and B10, were each subdivided into 20 small plats, each having an area of 12 by 45 feet, or 0.0124 of an acre. The wheat in 1919 was seeded with a grain drill, and the corn in 1920 and 1921 was put in with a hand planter after marking the ground so as to

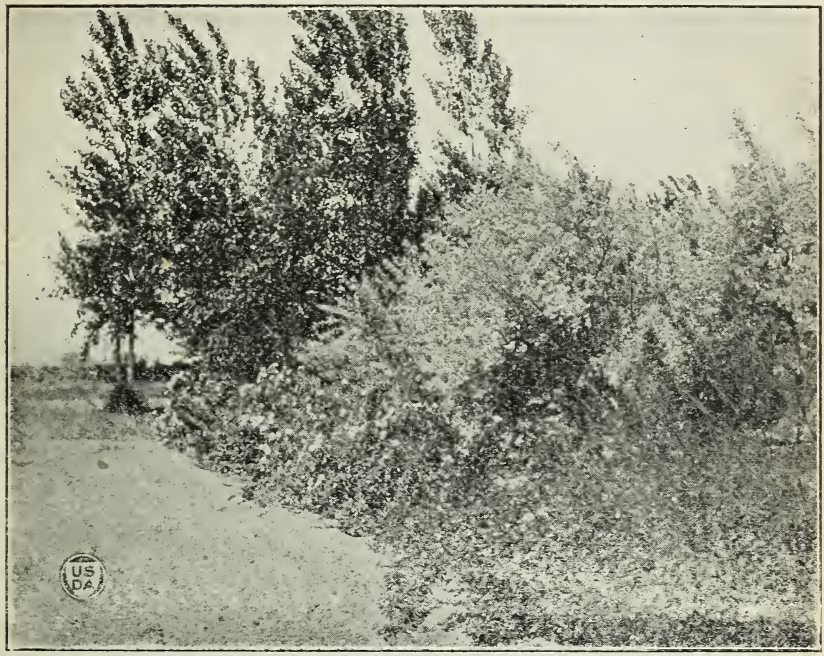

FIG. 4.—View on the Newlands Experiment Farm, showing how the gray foliage of the Russian olive contrasts with the dark foliage of the poplars.

have an equal number of hills in each plat. The yields given for 1919 include the weight of the air-dried straw and grain, and in 1920 and 1921 the corn was cut and weighed green.

The effect of the treatments was carried over for a short distance into adjacent plats, and for this reason only the two center rows of corn were cut and weighed. The weights given for corn were therefore obtained from an area of 0.0062 of an acre. The yields for the three years and the details of the plat treatments are compiled in Table 15.

TABLE 15.—*Results of the alkali reclamation experiment on field B, of the Newlands Experiment Farm in 1919, 1920, and 1921.*

Plat treatment.	Yield per plat (pounds).								
	1919, wheat.			1920, corn.			1921, corn.		
	Series.		Total.	Series.		Total.	Series.		Total.
	1	2		1	2		1	2	
Check	0.31	0.25	0.56	0.50	1.00	1.50	2.10	6.40	8.50
Gypsum, 110 pounds	.44	.38	.82	.25	1.25	1.50	2.00	4.30	6.30
Gypsum, 28 pounds	.38	.25	.63	.50	2.25	2.75	2.90	6.40	9.30
Sulphur, 28 pounds	.31	.25	.56	.38	1.25	1.63	1.50	7.80	9.30
Sulphur, 7 pounds	.38	.44	.82	1.13	2.25	3.38	5.30	7.40	12.70
Check	0	.38	.38	.50	2.25	2.75	2.00	7.50	9.50
Manure, 700 pounds	.75	3.06	3.81	7.50	8.00	15.50	20.80	14.50	35.30
Manure, 1,400 pounds	.44	3.38	3.82	11.50	10.50	22.00	26.90	33.30	60.20
Manure, 2,800 pounds	.94	2.06	3.00	18.00	18.00	36.00	25.20	22.20	47.40
Manure, 1,400 pounds; gypsum, 28 pounds	3.00	3.13	6.13	25.00	32.00	57.00	38.00	49.00	87.00
Check	1.25	1.00	2.25	1.50	1.75	3.25	4.00	[1] 0	8.00
Do	1.25	.25	1.50	1.50	2.25	3.75	4.00	8.70	12.70
Manure, 1,400 pounds; sulphur, 14 pounds	4.56	3.44	8.00	24.00	21.00	45.00	59.20	41.00	100.20
Manure, 1,400 pounds; acid phosphate, 4 pounds	2.75	2.25	5.00	11.00	15.00	26.00	45.60	29.80	75.40
Gypsum, 28 pounds; acid phosphate, 4 pounds	2.88	.56	3.44	12.50	5.50	18.00	16.80	11.10	27.90
Sulphur, 14 pounds; acid phosphate, 4 pounds	2.75	.50	3.25	1.50	2.50	4.00	10.40	7.00	17.40
Check	.56	.13	.69	1.50	.75	2.25	5.60	3.50	9.10
Acid phosphate, 4 pounds	1.25	.50	1.75	3.75	2.50	6.25	3.80	7.40	11.20
Acid phosphate, 4 pounds; gypsum 28 pounds; manure, 1,400 pounds	1.81	2.44	4.25	19.00	19.50	38.50	38.70	36.10	74.80
Acid phosphate, 4 pounds; sulphur, 14 pounds; manure, 1,400 pounds	1.00	2.38	3.38	27.00	13.00	40.00	38.50	34.10	72.60
Check	[2] 4.31	.25	.50	[2] 27.50	1.00	2.00	.....	6.40	12.80

SUMMARY SHOWING THE RATIO OF THE YIELDS OF CHECK PLAT TO THE YIELDS OF TREATED PLATS.

No.	Plat treatment.	1919	1920	1921	Average.	No.	Plat treatment.	1919	1920	1921	Average.
1	Manure, gypsum	326	1,810	1,060	1,065	8	Manure	508	545	384	479
2	Manure, phosphate, sulphur	398	1,940	610	983	9	Gypsum, phosphate	349	633	264	412
						10	Sulphur, phosphate	382	157	177	239
3	Manure, phosphate, gypsum	403	1,810	685	966	11	Phosphate	401	194	112	236
						12	Sulphur	196	135	137	156
4	Manure, sulphur	596	1,300	840	912	13	Gypsum	129	138	105	124
5	Manure	338	1,020	677	678	14	do	158	86	73	106
6	do	200	1,180	550	643	15	Sulphur	125	73	102	100
7	Manure, phosphate.	424	825	603	617	16	Check	100	100	100	100

[1] The growth on this plat was destroyed by standing water, which was not drained after irrigation. The yield of the corresponding check in series 1 has been used.
[2] This figure was not used in the average, as a part of the plat was in an area of good soil.

In the summary of Table 15 the ratio of the yield of the check plats to the treated plats is shown. In calculating these ratios it is assumed that the soil changes gradually from one check plat to the next. Observation has shown that this is a nearer approach to accuracy than if the average of all checks be taken as a standard in measuring the effectiveness of the treatments. The treatments are arranged in the summary in the order of their effectiveness, as indicated by the average of the results for three years. It will be noted that manure applied alone or in combination is more effective than any other treatment.

Soil samples were taken from each plat in 1918, before the treatments were applied, and three samples were analyzed for alkali salts. Black alkali was present in all plats, and sufficient alkali salts were present to render the soil nonproductive.

In 1919 the plats that had been treated with manure made growth so much better than any of the others that soil samples were taken from each of the manured plats and some of the checks in order to ascertain if any improvement in the alkali condition could be noticed. The results of the analyses are presented in detail in Table 16.

It will be seen that the percentage of sodium carbonate materially decreased in all the manured plats and that in some cases, especially where sulphur or gypsum were used, the percentage of sodium sulphate was increased. It is impossible to judge the relative toxicity of a number of soil samples containing variable quantities of salts

FIG. 5.—Plat B10 on the Newlands Experiment Farm, looking north, on July 23, 1920. Manured plats in all cases carry heavy growth.

of different toxicity by the total alkali present. It is necessary to take into consideration the quantity and the toxicity of each individual salt and score the soil accordingly.

At the Newlands Experiment Farm a method of scoring alkali soils has been worked out that has been found by actual field test to be a very good guide in determining the suitability of alkali soils for crop growth. In scoring a soil, deductions from the perfect score, 100, for each 0.01 per cent of each salt named, are made as follows: 10 points for sodium carbonate, 2 points for sodium bicarbonate, 2 points for sodium chlorid, and 1 point for sodium sulphate.

In Table 16 it will be noted that the treated plats showed greater improvement than the check plats and that the soil score corresponds very well with the yield ratios. Although the results of this experiment are decidedly positive in showing benefit from the use of manure

in the reclamation of the soil, it would not be safe to assume that soils of a different type would be improved by the application of manure, for experiments conducted on a heavier soil showed decidedly good results with gypsum and sulphuric acid and no noticeable

FIG. 6.—Plat B10 on the Newlands Experiment Farm, looking north, on August 17, 1921. Compare this with Figure 5.

benefit from manure. Manure seems more likely to be beneficial on soils of the cement-sand type than on adobe soil carrying black alkali.

TABLE 16.—*Analyses of soil samples, showing the effect of manure on the alkali content in plats 9 and 10 of field B of the Newlands Experiment Farm in 1918 and 1920.*

[EXPLANATION.—In column 2: C=check, G=gypsum, M=manure (quantity stated in pounds), P=phosphate, S=sulphur. In columns 6 and 11: T=trace. In columns 13 and 15: B=bad, G=good, M=medium, P=poor.]

Plat.		1918, after treatment.					1920, after treatment.					Final character.	Average.		
No.	Treatment.	Na_2CO_3.	$NaHCO_3$.	NaCl.	Na_2SO_4.	Score.	Na_2CO.	$NaHCO_3$.	NaCl.	Na_2SO_4.	Score.		Score.	Character.	Yield ratio.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
B9, 6..	C.....	0.084	0.063	0.009	T	2	0.058	0.126	0.006	0.030	13	B...	33	P.	100
B10, 6.	C.....	.053	.079	.066	T	30	.032	.063	.006	0	54	M...			
B9, 8..	M, 1,400..	.090	.046	.010	T	−1	.011	.126	.023	.033	56	M...	57	M.	678
B10, 17	M, 1,400..	.114	.084	.009	T	−33	.016	.109	.018	0	59	M...			
B9, 9..	M, 2,800..	.095	.100	.012	T	−17	0	.109	.012	T	76	G...	58	M.	643
B10, 18	M, 2,800..	.069	.095	.010	T	10	.025	.160	.009	0	41	P...			
B9, 12.	M, S.....	.110	.058	.012	T	−24	0	.067	.012	.150	69	G...	68	G.	912
B10, 2.	Ma, S.....	.053	.104	014	T	23	.011	.084	.003	033	67	G...			
B9, 13.	M, P.....	.105	.088	.015	T	−26	.016	.084	.044	.060	52	M...	54	M.	617
B10, 3.	M, P.....	.021	.108	.066	T	46	.016	.130	.012	0	56	M...			
B9, 18.	M, P, G..	.054	.120	.009	T	21	.011	.093	.021	.125	54	M...	60	M.	966
B10, 8.	M, P, G..	.053	.095	.008	T	26	.011	.084	.009	.033	67	G...			

ALKALI SOILS OF THE NEWLANDS PROJECT.

The soils of the Newlands project have been laid down under circumstances which resulted in an uneven deposition of clay, sand, and gravel, so that farmers frequently find that their fields are very spotted. If the spottedness were confined to the mechanical assortment of the soil, little difficulty would be encountered in conducting a successful agriculture, but another form of spottedness occurs, brought about by the uneven distribution of the various alkali salts which have the effect of either preventing or seriously reducing crop production. It is of importance that the alkali problem be clearly and simply stated, for many wrong conceptions exist among farmers on the project, and new settlers from the Eastern States, as a rule, know nothing of alkali.

KINDS OF ALKALI.

The alkali salts most commonly occurring on this project in sufficient quantity to be harmful to crops are: Sodium carbonate, sodium

FIG. 7.—Plat B9 on the Newlands Experiment Farm, looking north, on July 23, 1920. Heavy growth occurs only on soil to which manure has been applied.

bicarbonate, sodium chlorid, and sodium sulphate. In addition to these, other salts are found with potassium, calcium, or magnesium bases, but these commonly occur only in small quantities or are harmless, so it is necessary to consider only the four sodium salts.

SODIUM CARBONATE.

Sodium carbonate is the most harmful of the salts named above. It is the one commonly called "black alkali," for the reason that when deposited on the surface of the soil it is black or dark brown. The pure salt is white, but in the soil it dissolves organic matter and takes on a darker color from the impurities absorbed.

Black alkali is found to some extent in most parts of the Newlands project, and where it occurs it causes considerable injury to crops. An exceedingly small amount, 0.05 per cent of the weight of the soil,

will generally prevent crop growth. When present in such minute quantities it is not usually visible, and the grower of the crops may not suspect its presence. Sometimes there is a visible crust on the surface of the ground and yet not enough in the soil to injure the roots of the plants. Not every dark stain or crust on the soil surface is black alkali, for manure or other organic matter often leaves dark stains so closely resembling black alkali that they can be distinguished only by chemical test. Many farmers are deceived into thinking they have black alkali when there is really no trace of it in their soil, just as others think they have no black alkali when a chemical test may show its presence in toxic quantities.

When black alkali in sufficient quantity comes in contact with plant roots it dissolves or "eats them off." Sometimes it occurs at the surface in sufficient quantities to girdle the growing plants.

FIG. 8.—Plat B9 on the Newlands Experiment Farm, looking north, on August 17, 1921. Compare this with Figure 7.

Again it may be found in the subsoil, but with little or none in the surface 8 or 10 inches. The result of this condition is a dwarfed crop, because the roots rot off when they get down into the alkaline subsoil. The short alfalfa so commonly seen in spots in many of the fields of the project is frequently the result of black alkali in the subsoil. Crops growing on such land suffer for water between the regular irrigation periods, for the plants are supported only by surface roots.

When black alkali is the cause of this dwarfed condition, an examination usually shows that the plants are without taproots but with well-developed side roots. The taproots could not penetrate the alkaline subsoil; consequently the plants are supported only by the surface roots, which explains the slow growth and inability to stand drought.

Black alkali produces certain characteristic effects upon the soil. It puddles the soil, making it impervious to water, and often causes the formation of a hardpan at a little distance below the surface. It is the imperviousness of soil containing black alkali that makes this salt so hard to eliminate.

SODIUM BICARBONATE.

Sodium bicarbonate is the common cooking soda which is so important an article in kitchens. It is found to some extent in nearly all soil samples, but in small quantities it may stimulate rather than retard growth. It is not so harmful to the roots of plants as is the sodium carbonate, but under certain conditions it changes to the sodium-carbonate or black-alkali form. It is considered a dangerous salt and is often determined as sodium carbonate by chemists, but

FIG. 9.—Manured corn at the left and unmanured corn at the right in plat B10 on the Newlands Experiment Farm, on August 17, 1921.

such a method is hardly justified, for the bicarbonate is only about one-fifth as toxic as the carbonate. So long as the soil is properly handled and not water-logged by overirrigation the bicarbonate appears to be a fairly constant salt.

SODIUM CHLORID.

Sodium chlorid is the common salt used daily on our tables. It is less harmful to plants than sodium carbonate, but when there is more than 0.15 per cent in the soil, the common crops begin to show ill effects. It has the effect of rendering the soil somewhat impervious, but not to such an extent as the sodium carbonate. A soil carrying as much as 0.5 per cent is worthless for agricultural purposes until some of the salt has been leached out.

SODIUM SULPHATE.

Sodium sulphate is commonly known as Glauber's salt and is used as a drug to produce laxative effects. It is the least harmful and usually the most common of the salts seen crusting the soil in so many parts of the Newlands project. Seeds will seldom germinate in soil carrying 1 per cent sodium sulphate, and crop growth will usually be retarded when there is more than 0.2 per cent in the soil. Sodium sulphate and sodium chlorid constitute the greater part of the so-called "white alkali."

IRREGULAR CHARACTER OF THE ALKALI DEPOSITS.

All who have had experience with alkali soils know that the salts are not everywhere equally distributed, but that they are much more abundant in some locations than in others. Some farms contain few unproductive areas, while there are others where the alkali spots cover the major portion of the land.

In attempting to reclaim alkali lands it is helpful to know why the alkali has been deposited in this irregular manner, instead of being more evenly distributed throughout the soil.

HOW ALKALI IS DEPOSITED.

Alkali salts are dissolved by water from the decomposing rocks and the soils through which it passes and are carried from the places where they are brought into solution to other locations where they are left as salt deposits by the evaporation of the water. The dissolved salts stay in solution in both running and still water and go everywhere with the water until it evaporates, and then only are they left behind.

When an old lake dries up, as did the great Lake Lahontan that once existed over the area now occupied by the Newlands project, there are left high and low places, swales, sloughs, ponds, puddles, and water channels running here and there. Evaporation then takes place unevenly from the surface of the land, being greater from those areas where there is the greatest amount of moisture at the surface and least from those locations where the surface contains the least moisture. Generally the alkali accumulates at those places where the most water is evaporated. Whenever the surface of the ground is kept constantly moist by the underground water a large quantity of salt is likely to be left behind by the evaporation of the water.

EFFECT OF A HIGH WATER TABLE.

Wherever the water table rises to within 3 or 4 feet of the surface, water is brought up by capillarity, and on evaporating it leaves its salts on the surface of the ground. Those who have a high water table beneath their farms have probably watched with alarm the gradual increase of alkali on some of the lower fields.

In locations where there is poor drainage and a resulting high water table there is a constant upward movement of water which brings with it salts in solution to be left at the surface of the ground when the water evaporates. Seepage of water from a ditch or canal may have the same effect on adjacent lands as if a high water table were present, for the strata of soil may be such that the seepage water from the ditch will move laterally, emerging at some distance and bringing with it the salts dissolved in its passage through the soil.

ALKALI A DRAINAGE PROBLEM.

The alkali problem is essentially a drainage problem. With a high water table and poor drainage, alkali lands are almost certain to be developed, and when alkali is present under these conditions it is hopeless to attempt to reclaim the land until the water table is lowered to such a point that there is no longer a continual rise of water from beneath the surface. The main movement of water must be down and not up, for the irrigation water in its downward course dissolves the alkali, carrying it into the water table below and out into whatever drainage channels exist.

NECESSITY OF DRAINAGE.

Wherever there is an accumulation of salts from seepage it will be necessary to remove the cause before the alkali can be permanently removed. Even if the alkali deposits at the surface of such lands were entirely removed by heavy flooding or by scraping them off, the remedy would not be permanent in its effects, for a new deposit would at once begin by the agency of the water brought from the reservoirs below. After good drainage has been provided and the salts are once removed, the alkali will not again return to the upper soil, and the reclamation is permanent so long as the water table remains at a sufficient depth beneath the surface.

RECLAMATION METHODS.

The first step in reclaiming alkali soil is to see that good drainage is provided. After drainage is provided the alkali in the soil is removed a little at a time by each successive irrigation or fall of rain. The water in its passage downward through the soil dissolves the salts and carries them away. When the soil is reasonably porous and there is ample drainage little trouble should be experienced in getting rid of the alkali, but when the soil is impervious, as is frequently the case, the problem is altogether different, and the reclamation of the land may become exceedingly difficult.

IMPERVIOUS SOIL.

Impervious soil carrying an excess of alkali can not often be reclaimed by application of water to the surface. There are large areas of land throughout the West where the soil is so impervious that the water remains on the surface until removed by evaporation.

When soil is of this nature it is obvious that providing good drainage will not of itself remedy the saline condition. Methods must be used which will make the soil sufficiently porous to allow the downward movement of the water. The plowing under of organic matter, such as a growing crop of sweet clover, or an application of coarse manure, will help to some extent on some soils, but usually a chemical treatment is necessary if the soil is very impervious.

CHEMICAL TREATMENT OF ALKALI SOIL.

A number of chemical treatments have been suggested and tried on the impervious soil carrying black alkali on the Newlands Experiment Farm.

The application of gypsum has been tried more extensively than any other treatment and usually with beneficial results. On the

adobe soil on the south side of the farm a better stand and increased crop growth were obtained on every plat receiving an application of gypsum, but in no case did the soil on any plat become sufficiently good to grow full crops. The surface soil was in all cases much improved, but alkali salts remained in the subsoil in toxic quantities and prevented normal crop growth. The surface soil of the untreated check plats has remained hard and impervious throughout 14 years of experimentation, while the surface of the gypsum-treated plats became more mellow and easily worked and has continued to retain its improved character.

Gypsum was found to be beneficial on the grounds of the ditch-rider's house near the sugar factory; so much so that the exact line of application was evident by the increased crop growth. Other trials, viz, on the farms of G. W. Lattin, Dan Evans, and C. G. Swingle, were without visible effect.

Sulphuric acid was tried on two plats of nonproductive adobe soil with results very similar to that obtained by the use of gypsum. The soil took water better, and it was easy to obtain a fairly good stand of grain and alfalfa on the treated plats, but the yields obtained were never more than half as great as yields from good land. The check between the acid-treated plats did not permit the germination of seed.

Sulphur also has been tried in laboratory experiments and in small plat tests. Some improvement was noted, but it was not sufficient to justify a general application of sulphur.

Early in 1921 it was found by laboratory experiments [3] that aluminum sulphate was very effective in increasing the perviousness of soils and that soils having a tendency to bake very hard on drying were much improved by small applications of alum and were more easily worked. Alum had the effect of increasing the perviousness and reducing the cementation of soils. A few small field tests resulted in marked improvement of the physical condition of the soil and also in the germination of seeds, but the growth of the resulting crops, although better than on the untreated plats, was not wholly satisfactory. It is probable that a period of leaching with irrigation water should have followed the application of the alum, in order to wash out the excess of alkali salts. It should be understood that alum in itself does not eliminate alkali, but because it makes the soil more permeable, the alkali salts can be more easily washed out. Much more elaborate field experiments with these impermeable soils were undertaken in 1922.

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[3] Scofield, Carl S., and Headley, Frank B. Quality of irrigation water in relation to land reclamation. *In* Jour. Agr. Research, vol. 21, no. 4, p. 265–278, 1921.

Scofield, Carl S. The effect of alum on silicate colloids. *In* Jour. Wash. Acad. Sci., vol. 11, no. 18, p. 438–439, 1921.

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